# COLOR-BLINDNESS.

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### A LECTURE ON COLOR-BLINDNESS AND ITS PRACTICAL RELATIONS, DELIVERED APRIL 11, 1878, AT THE INSTITUTE OF TECHNOLOGY.



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*Mr. President and Members of the Society of Arts:*—It is rather curious that it is already one hundred years ago last year, that cases of color-blindness were first reported, till then the subject being almost unknown. From a hundred years ago last year till within the last quarter of a century, there has been but little said or done about it. Within this time a great deal has been accomplished, cases have been investigated, and of course the subject has naturally pressed itself upon ophthalmic surgeons as well as upon physiologists. Their attention having been called to it, the results of their investigations are now filling our special journals. It is difficult for me to enter upon the subject of color-blindness without a certain amount of preliminary explanation of the visual perception that to the most of you may appear quite elementary, but others may feel they need it in order to follow me in the subject as I go on. I will therefore show you here a section of the normal eye—the retina lines, the inside on which the light falls, here the optic nerve which carries up to the brain the sensation which the retina receives. To see an object distinctly we are obliged to turn our eye directly to it. If we look at a long word on a page, for instance, we unconsciously travel along the word in order to catch it, and that shows us that our point of best sight is directly in the centre. If you hold a letter before your eye, looking straight forward, and then move it along, you soon find that you cannot recognize it, that the form is lost. As we move it either outwards or inwards from the *macula lutea*, the "yellow spot," as it is called, the centre of the eye, the perception of form diminishes very rapidly. This is also true with reference to color. If, for instance, I hold up this red disk before my right eye, keeping my left eye closed, and then move it outwards, there is a point where it appears perfectly black; there is no color whatever, although its picture falls on the retina not very far from the point of best vision. So with other colors in varying degree.

Then another point with reference to the retina that I may speak of here, namely: Around the centre, supposing that is our point of best vision, there is a zone, close to it, in which we have a perception of all three of what we call the "base colors," red, green and violet; around that zone another, in which we have a perception of violet and green; and then there is a third zone where we have a perception of violet or blue. Perhaps it is hardly right to state it exactly in that way, but it is pretty much so—that there is one zone where we have a perception of three colors strong, another zone where one color falls away, and another zone where we only have a perception of blue or violet. Therefore, you see that portions of the retina itself are, so to speak, color-blind.

There is another thing I would call your attention to which many of you may have heard of. Cataract, in old age, is simply the crystalline lens becoming more and more yellow, up to almost blackness. Now, when the crystalline lens becomes yellow it becomes opaque, so a person cannot see, although there may be perception of light. When we remove the cataract we take it out of the eye and expose the retina to light which is not yellow. The consequence is that the person sees, how? Many an old person whom I have operated on for cataract, after it is removed and they are able to use their sight, complain that everything is blue; that their children's faces, for instance, look blue, and they naturally often express considerable disappointment that life is to be to them wholly blue. This is merely because they get the complementary effect, and objects become blue to them because their light has been yellow. Although this may be called temporary color-blindness, it really is not immediately connected with the subject; but I have been so often asked in regard to the point, that I thought it would be better to explain it here.

Now I must accept, from the best authorities on the subject,—although I may differ from any artists who are present,—red, green and violet as being the three base colors. The theory of the base colors known as the Young-Helmholz theory—a theory that was started by Thomas Young at the beginning of this century, and has been worked out in this quarter of the century by Helmholz,—is namely thus: That these three colors combined together form the spectrum, as light passed through a prism gives us the colors with which we are all familiar. Now, to use Helmholz's diagram let this hill, to call it so, represent red, and this one green and this one violet. Now if we superimpose them we have a diagram which gives us an idea of the spectrum. If we come down here we get so much violet and so much green, and so much of red making up the blue, and so on all the way down through; the idea being this, that for each color, red, green and violet, there is a corresponding nerve termination in the retina, one for red, one for green, one for violet. That is the theory, and we simply accept it because that is the best one we now have to work with, whether its validity be hereafter proved or disproved.

It is a very difficult thing for me to explain to you what color-blindness is, but perhaps this theory of Helmholz may help us somewhat to express it. We see here in Helmholz's diagram these three hills of color, simply superimposed in this other. Now, supposing a person is red-blind, we must leave out that hill and then we shall have left the other two, green and violet. Suppose he is green-blind, we leave out that hill, and if he is violet blind we leave that out, and have only the green and red. Now congenital color-blindness is an inability to distinguish one of these three base colors from gray. That is putting it in the shortest way possible, and perhaps expresses it as well as one can. Now, a person may be color-blind in red, or in green, or in violet, or a person may be color-blind in red and green, or a person may be totally color-blind, so as to have only the perception of form without any sensation of color. You may have heard of persons who have become color-blind from disease. It comes especially with diseases of the optic nerve, where it becomes atrophied as the person gets on in life, and that is peculiarly a hereditary disease. In fact, wherever we have color-blindness associated with certain cerebral symptoms and appearances seen in the eye, we recognize the disease thereby. We also have color-

blindness from the abuse of alcohol and of tobacco. We have temporary color-blindness caused by certain medicines, for instance santonine. Color blindness is also caused by certain forms of injuries, those occurring on railroads, for instance, when the person is violently shaken up, and, although at first not feeling injured, the nervous system has been interfered with, and color-blindness becomes a symptom. We may also have color-blindness in merely one eye in cases where an injury has been received, probably on the opposite side of the head. Cases have been reported where after injury green-blindness existed only in one eye. That never is the case, however, in congenital blindness. Then both eyes are deficient in color perception.

Now as to the dangers of color-blindness. All of you that have taken the horse-cars tonight and looked out for the special light, or more especially you that have come in on the railroads, have been behind a man who certainly ought to be able to distinguish between a red and a green light at the switches, and gates, and stations, to know whether to stop or pass, and the signals on the rear of the train ahead of him. You all know that even within a few years every vessel after sundown must show upon one side a green and upon the other side a red light, that the safety of that vessel and of others in its neighborhood, or passing it, depends upon those lights being properly placed, interpreted and distinguished. Remembering that when the green light is seen the vessel is going one way, and when the red light is seen the vessel is going the reverse, and when both are seen the vessel is coming toward you, and if the vessel swerves from her course one alone is seen, you deciding by the light seen which way to change your direction to avoid collision, the danger from the inability to distinguish these two colors is at once apparent. But the dangers of color-blindness I have discussed elsewhere. The State Board of Health in their report this year will soon publish an extended article from me on this special branch of the subject. Every one, I think, will appreciate the magnitude of the danger without any further discussing it.

As to color-blindness being hereditary, I have only rarely, that is, in two or three cases out of perhaps forty in number, found that the parties did not state that some other member of their family was also color-blind. So, if you find ten color-blind in a community, you are pretty sure to find they are matched by ten more in some of their relatives—either a father or mother, or brother or sister, or aunt or uncle. It is like any other hereditary defect, as for instance, six fingers or six toes, and the other marks, like a white lock on the forehead. We know how these defects jump one generation and then appear in the next, and so on. Just so color-blindness appears and disappears. A person is born color-blind, and lives and dies so. I do not dwell on this, as I have presented it in an article published in the Boston Medical and Surgical Journal of March 28.

It is nonsense to suppose that when a person cannot distinguish these red and green disks by their colors, to suppose you can make them so do by telling them that the one is red and the other green. When they have learned that the one you hold in your left hand is red and the one in your right is green, they will say so; but if you change the objects from one hand to the other and hold them up they will tell you the red one is green and the green one red. Color-blindness is absolutely incurable, and it cannot be remedied by any available means. One would think that we might enable a color-blind person to see in some way by looking through colored glass. I will not enter into that, because it would be waste of time. If a person is color-blind there are no available means to help his faulty perception.

As to its frequency. Here, again, I will only say a word, because I have discussed it in my article in the report of the State Board of Health. It is probable that one in twenty-five in our community is color-blind, more or less. Color-blindness varies as the power of vision varies. For instance, one person is able to read these letters of my test types from across the room, another person these larger letters, and another these, and so on. Just so with color-blindness. One may see a little something which on the whole to him seems red, which to another person is black; and so with green. I have tested a large number of students of the Institute of Technology and of the various departments of Harvard University—about 650. One in twenty I found color-blind. I mean marked cases. That is in males. How it is in females I do not yet know, and I had rather not be quoted. I have investigated this point to a certain extent, and am now engaged in testing females for color-blindness in our city schools and at Wellesley College, but I do not care to report what I have already found, because the ratio up to this time may be changed by the next few hundred. In regard to the ratio of color-blindness between men and women, the reports from the other side of the water vary so that I do not like to accept them. One of these days I hope to be able to report definitely as to women. We may consider at any rate that there are at the least 10,000 color-blind people in the city of Boston.

Color-blindness amongst the railroad employés, it is rather curious to say, is above the ratio of the community. For instance, on the other side of the water, from three per cent up to ten per cent of the people actually employed on the railroads, on whom the proper display of signals and the proper care of the trains are dependent, are color-blind. Professor Douders, and of course there is no higher authority, examined 2300 persons on one of the railroads in Holland, and he found 152, one in fifteen, color-blind; that is, unable to tell quickly and at once "this is a red light, this a green light; stop the train or let it go ahead." Every now and then something crops out in the newspapers on this subject. Perhaps you would not notice it, but it interests me. I came across an article in the August number of the Galaxy that was rather irritating, for it was peculiarly a wrong statement of the facts. A year or two ago there was an accident in England on one of the railroads near Arlesley, supposed to be due to color-blindness. Of course the thing was quickly taken up as a sensation. Whether the engine-driver was color-blind or not I will not undertake to say. At any rate it led to a good deal of controversy and the gentlemen who examined the railroad employés, the railroad surgeons—something we don't have in this country, but they do the other side of the water,—felt a little abashed at the idea that some men whom they had passed as being competent to distinguish and rightly employ the flags and lanterns, were color-blind. They accordingly came out in the newspapers, and said that color-blindness was exceedingly rare. There were a series of articles, and it led to some discussion in the medical journals, but it soon died out. Somebody must have read this and noticed it in the Galaxy, where it reads as if it has occurred in this country. We are told by the Galaxy that color-blindness is exceedingly rare and easily detected, and we can therefore dismiss the idea of danger from our minds. It is curious to see how a thing, hushed up in England by surgeons who were unwilling to acknowledge that a man might be color-blind and pass through their fingers, should be brought over here, and our fears thereby quieted, where there is no examination whatever made.

Before I explain the signals that are used on the railroads, I must discuss a little with reference to pigments. No scientific man can begin to talk with an artist without their being at once at loggerheads; because the scientific man is talking about spectrum colors, that is, the colors that the sun makes when light passes through a prism, whereas the artist is talking about the colors of his paints. We must always keep distinct in our mind the fact that pigments are not spectrum colors. The pigmental red is by no means the red of the spectrum. Now, if we take, for instance, the red of the spectrum, and its complementary, the green of the spectrum, these two colors, when mixed together, should give us, of course, white. But everybody knows, who has tried, how extremely difficult it is to find any two pigments that, mixed together, will produce white. I have here a card, with a series of complementary colors, arranged by my friend Mr. Köhler. There is an outer ring, in which there is the alternate of one and the other color, and there are a series of rings, one inside of the other, each containing two colors. Now, if these colors are complementary, the moment we mix them together by rotating the disk they should disappear, which they do. All the color is gone, and we have a very good representation of white, because they have passed over the retina so rapidly that they are blended or mixed. There is nothing I am in search of more at the present moment than pigments which shall be pure and truly represent the colors of the spectrum. Nevertheless, the pigments which we do have are so good that I do not despair, and I trust my friend Mr. Köhler also does not despair, of finding one of these days

pigments that shall represent the spectral colors. They are not so bad now, after all, for you see red, green and violet, mixed on this revolving disk, give us a very light gray, nearly as good as the many-colored card used to show the experiment in the schools, now revolving on the other wheel; so that, even with pigments, we may get a pretty good result.

Now another matter before we come to the signal lights—the change of pigments by artificial light. Everybody knows how all colors seem to be gone in the moonlight. How in a room furnished in red a few minutes after sundown you stumble around among the furniture; but if your room has blue paper and blue-colored furniture you can see much longer. You know how the blue and green shades of ladies' dresses change at night. All that must be taken into consideration with reference to color. We must not forget that this applies to the color-blind as well as to all of us.

Now I pass to another portion of the subject, and that is as to the signals. You say at once, if persons are so color-blind that they cannot distinguish a red from a green light, why not give these up? Why not have three lights together meaning danger, and two to signify safety, etc., or have a diamond-shaped light or a round light, and so on. I must simply answer: Practically we have got to use red and green on the sea for port and starboard, and on the railroads we must use red at night, and as we need another color to show safety and for other purposes, we must use its complementary,—green. Now, I have been asked so many times with reference to this point, that those who are familiar with it will pardon me if I take some few minutes to show the real appearance of the colors.

In one opening of this screen I put red glass, and in the other successively violet, orange, blue, with varying depths of each, and you see you do not have the contrast needed, and which would be so strong by daylight. But when I use green, or better bluish green, you recognize immediately a strong contrast of the two lights.

I noticed a little article in the Scientific American, where a gentleman proposed that on vessels they should use a variety of colored lights. After having seen what you have, I think you will be prepared to smile at the idea. He proposes that north should be red, south should be green, east shall be yellow and west shall be white. Now, when the vessel is sailing due north, she shall hang up on her side a red light. If she is sailing north-northeast, one light under the red light; if northeast, she shall have two lights, and, if east-northeast, three lights, etc., and so on with the other points of the compass, every time she changes her course changing her lights. You have seen what it would amount to. That is a system proposed in the Scientific American. I have never known it to be carried out, and I hope it will not be tried on the vessel I am a passenger in.

There are, probably, one in twenty or twenty-five in our community who are color-blind, who cannot tell one of these colors from the other, or will make mistakes under a variety of circumstances, or who can only say after looking at them carefully that they think one is different from the other. That is incurable; they are born so, they die so. What shall we do? There is no other way than to eliminate these people from our railroad employés, from our pilots, our steamboat helmsmen. And so we come to what is really the object of my remarks this evening—the test for color-blindness. It would seem very easy to detect persons who are color-blind. It is not so if they want to deceive you, and hence the value of tests. I shall run over the various tests that have been used in the past years, and gradually abandoned because unreliable. There is a test that was proposed many years ago which depends on what is called complementary shadows. If I have a round hole in a screen and cover it with glass, and let light through it down on to a piece of paper, that paper will be illuminated and have a color. If now I hold up a pencil, that pencil, of course, will throw its own shadow upon the paper, which shadow will appear of complementary color. Now then, of course, a color-blind person does not see that complementary shadow as the normal eye does. This has been used as a test for color-blindness. It was proposed by an Italian savant by the name of Ragona Scina. It was followed up by Professor Rose, a German, who has done so much in the study of color-blindness and color-perception. It was also followed up by Professors Weber and Cohn. Professor Holmgren of Upsala, Sweden, proposed another method, by which he used two shadows, and was enabled in that way to ask for a decision of the person whether these shadows were alike or varied. You may see this any day at the table if you have a glass of claret, particularly if it is in a champagne glass and the gas-light is above it, in the shadow on the table-cloth. If you take a knife-handle and hold it across so as to throw a shadow upon it, that shadow will appear the complementary color. If you have a red wine it will give it a greenish tinge. You can see it if you are reading a book by the yellow gaslight, and you happen to lay across the page your paper cutter, for instance, the shadow will appear blue, because you are using the yellow gas. These are what are called complementary shadows.

Now there is another means—the use of simultaneous contrasts. That was proposed a good many years ago, and, owing to the experiments of Professor Meir, it was followed up by Professor A. Weber, and he reported to the Ophthalmological Society at Heidelberg in 1871, and again in 1875. It was this way: Take a green surface, for instance, and lay on it a strip of gray paper half an inch wide, and look steadily at it; that gray paper begins to look of the complementary color of green—namely, red. It does not do so to a color-blind person. We ask them to look, and their report is that it does not look to them as to us. We, therefore, know that their color perception must be at fault. Then another means of using simultaneous contrasts was proposed long ago, and was again brought forward by Professor Cohn in the Centralblatt für Augenheilkunde. It is this, and anybody can try this experiment. All you need is to take two little squares of black cloth and put them on a piece of paper, then bend the paper up in the shape of a book, so that one piece of the cloth shall be on each page, and put a piece of blue glass between them. As I hold this now and look down, I see one blue and I see the other one yellow, strongly marked if the glass is sufficiently tinted. Now, the color-blind person does not see that. He will give you a very different report; and by that way we can detect whether he is color-blind or not.

Another method, which has been spoken about by Professor Pfluger in the March number I have just received of the Centralblatt für Augenheilkunde. He speaks of the method that was brought out by Professor Bezold, and is described in his book, translated by my friend Mr. Köhler. It is this: If we have on a red ground black letters, and we cover them over by a thin tissue paper, these black letters change color. For instance, black type on a red ground, seen through white tissue paper, assumes a tinge of bluish green, and black type on a blue ground, seen through a tissue paper, assumes a tinge of yellow brown, that being the complementary color.

A method proposed a long time ago by Professor Snellen, to print type of different colors, red, yellow, green, blue and so on, does not work at all.

Another method, and one that you, perhaps, wonder I have not spoken of before, is in reference to the spectrum, the light through a prism spread out so as to give you a perfect spectrum, and then ask the person to be tested, "How far do you see red?" One may see it one distance, and another another distance, and so on. One person may be pretty much confused as to red, another as to green, and to another person it may be all black.

Another method proposed by Professor Maxwell is revolving disks,—an arrangement by which you merely slide one over the other and may have a little or more of one color or another. In that way we can compare, for instance, a card that shall be so much black and so much white, as little or as much as we desire, with another one that shall be as little or much of green as we want. We can compare them also in this way, black and white in the centre, which when mixed give gray and our color in the outer ring.

You see that in all the tests that have been proposed, you have to ask the persons what colors they see, or what they see, and so on. That is not the proper way. Professor Helmholz said, some years ago, that any test where we call on a person to name a color is no test at all. Why? Because there is no nomenclature in color-blindness. If we had another set of persons come into the world who could see colors beyond the spectral red or violet, their nomenclature would be unintelligible to us, and we could have no common ground on which to talk in reference to color. The color-blind person calls this pink and that green; but he is only using names he has heard. If he has heard a thing is green he calls it green. If the chairs in his parlor have always been green, and you put in

a new set of red, he will go on calling them green. Any attempt to test people by calling on them to decide by name wont do. That was spoken of as long ago as 1837, when Professor Seebeck published an exceedingly interesting article in Poggendorf's Annals. Also Professor Wilson, who published a book on color-blindness, the result of his studies between 1851 and 1855 on color-blindness in England. He let people pick out pieces of worsted that looked like one selected.

Another method proposed by Professor Stilling of Cassel was to do this, to endeavor to get something by which we could avoid asking people what they saw,—red, green or anything else. There is a black ground, and upon it red letters. Now a person who is color-blind cannot see those red letters, and when you ask him what letters are on there, he is unable to say. However, a person may see them if he gets a right reflection of the light, and an engineer will be careful to get the right light and make out the letters. It has been now given up. He since has invented a different method by which the previous difficulties are avoided, as you can see by these cards on which are letters.

To a person who is color-blind you can say, There are letters on there; what are they? If you who have normal color perception were to hold before your eyes the complementary colored glass, you also could not see the letters on these cards. This, of course, is a good practical test so far as it goes.

We have color-blindness in diseases, and it is a symptom which is of considerable importance, because from it we are able to make up some of our diagnosis. It is, therefore, necessary to have some means of detecting it, and detecting it quickly. I have here Woinow's card. On the outer ring there are two colors only, two of the three base colors; on the next ring two more; on the next ring two more, and in the centre black and white. These are divided up. This is based on the Young-Helmholz theory of the three base colors. When I turn the wheel the colors blend together, and the inner ring next the black and white will appear, in the day-time, quite yellow, etc. Now, to a person who is color-blind, the ring which does not have his color will appear gray, like the centre, composed of white and black. In the next ring we have no green; a person who is green blind will see that gray, and so on. A person that is violet blind, there being no violet, in this outer will see that gray. Why? If I am violet blind, cannot see violet, then the mixture of red and green to me will be the rest of the spectrum; it will be white light, or so nearly white as may be, that is gray.

A test has been used by Professor Donders of Utrecht which is extremely practical. By the tests thus far spoken of, it is simply shown that a person is color-blind; and we haven't anything yet that will show us he is color-blind 95 per cent, of 80 per cent, or 60 per cent. The superintendent o a road will say: "What can the man do? What shall we let him do?" And we can reply, that man is 65 per cent or 75 per cent blind. Now, Professor Donders proves this, and this is the way he examined the men on a railroad and found one in fifteen color-blind. He places a colored disk on a piece of black velvet and lets the man stand off fifteen feet. If he cannot see it, let him come up to twelve feet and so. He sees something; don't know the color. He comes up to nine feet. "That is red." Very good, then, his perception of color is so much lost, and you have it in figures. Another test of his similar to this, I will speak of without going into detail. It is, to let light through a hole of a certain number of millimetres pass a colored glass, and find out at what distance a normal eye can see it, and then make the allowance for the distance a defective sight requires. If a man says, "I am near-sighted," very well, he must put on his glasses, and you must be sure that he has exactly the right glasses, so that he can have the best use of his sight, or if he needs glasses for over-sight, etc. Therefore, this test requires the correction of defective vision as far as it can be done.

Another test, which is the one I am now using, is so simple and sure and practical and important, that when I show it perhaps many of you will say: "What is the use of all this talk? Why didn't you begin with that, and we should have been satisfied, because there is nothing else to do?" It is a test proposed by Professor Holmgren of Upsala, and which has been used by him in examining the railroad employés in Sweden, and which spread from there to other countries, and is now spreading all over Europe. It has been ordered by one government after another—the Russian government, for instance, the Norwegian and the Swedish, and railroad managers requiring an examination of the employés of the road. It consists of matching colored worsteds. If I had been disposed to make a little fun, I might have brought them in my hat. They weigh but a few ounces; cost but a few dollars; you can use them anywhere, whether it rains or shines, in doors or out of doors; it requires no apparatus; you need no artificial light; you do not call on the person examined for a single word, and may not be able to use his language, but, as long as he has his sight, you can test him for color-blindness. There are great advantages in this. If I had a lot of cards like these I have shown, they would soon soil. You would have to have both sides colored alike. The light reflects from a card in a variety of ways when it is laid on the table. A piece of worsted has only one color to it. These are analine colors, and come nearer to the spectral colors than any other pigment we have. It has also the advantage of durability as well as cheapness. Ladies will pick out these worsteds in one-half the time that gentlemen require. I examined in this way, at the normal school last Monday, eighty-one young ladies in sixty-five minutes. As I illustrate the results of these experiments, please remember that the color a person is blind in is gray to him. But there is something more. If you are red blind you cannot distinguish red from its complementary color, green. If you are green blind, you cannot distinguish that from its complement, red. So, practically, a person is red-green blind and green-red blind, or violet-yellow blind.

I have here some two hundred little knots of various colored worsteds, and place to one side a larger green one, as being the best to quickly make a color-blind person expose their defect. I then ask the person examined to select from the pile of worsteds what looks like the green, lighter or darker. The color-blind person is sure to throw out a wrong color in the first four or five. Which color he is blind in we can decide by a still further similar test.

This method has not been understood by the Germans. In Bavaria the railroad officials were directed to test their employés, but they ordered it in such a way as to necessitate the criticism of Professor Michel of Erlangen. Professor Holmgren writes me, within a day or two, that the Germans seem to resist this test. Here and there it is being used. For instance, I saw a report of one of the fleet surgeons of the Austrian navy testing his men in this way. The test is not so easy as one thinks, I was much disposed to get some gentlemen to help me carry it out. It takes up a good deal of time, and I thought I should be able to induce others to assist me, but I found that it required a good deal more on the part of the person who was examining than one at first would suppose. In fact, one must be pretty familiar with the whole subject, and must have a pretty thorough knowledge of the theory of color-blindness, and the particular working of this test, or be will make a sad mistake, and let through his fingers a person who is not much color-blind. Now it is just that person that we want to get hold of,—viz., those railroad employés who are not quick as to color, and who may run for a red light and get a green, or the sailor who puts the starboard light on the port side. There is no use in telling the railroad superintendent to test his men. It requires a person who is an expert to decide whether a person is color-blind or not. I have gone over this because there are no examinations for color-blindness throughout the United States. There is no such thing as a railroad surgeon in the United States. We have one in twenty of the community color-blind. Is there any chance that our railroad conductors, engineers, firemen and gate-men are all without color-blindness? I don't think so. In Europe they have been found as high as one in ten, five or six per cent on the northern European roads. I have been told by some of the students at the Institute here that they have known of at least one engineer whom they used to play with, in asking him the names of colors, and he didn't know red from green. As to color-blindness, red blindness is the most frequent, green blindness next and violet blindness is very rare indeed. In all my examinations, amounting now to pretty near a thousand, I have only found one person who was violet-blind, and that not to a very great extent.

I am very much obliged to you for your attention. I have spoken longer than I intended, but when one's heart is in a subject he is apt to let the words come faster and longer than he intended.